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ABSTRACT

This study explores students' conceptual thinking by examining the extent and complexity of their concept identification and organization in geography. The study investigated students' conceptual thinking through identification of salient geography concepts and construction of individual concept maps at three academic achievement and grade levels. The study involved 66 geography students from the 6th-, 9th-, and 12th-grade. Results from the study indicate students' conceptual thinking in geography is reflected in their achievement and grade levels. Other variables may be important contributors to students' conceptual thinking but those were not investigated. ANOVA results indicate not only increased conceptual understanding with increased achievement and grade levels, but also with increased performance on background knowledge, concept identification, and concept map construction instruments. Correlations among knowledge questions, number of concepts, and concept mapping scores also were statistically significant. In addition, attitude towards geography was statistically significant for achievement and grade; travel experience was statistically significant for achievement. (EH)

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Students' Conceptual Thinking in Geography

by

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Introduction

An examination of students' conceptual thinking in geography is vital to understand how they learn the subject. However, according to several studies (Cirrincione & Farrell, 1988; Marker & Mehlinger, 1992; Persky, Reese, O'Sullivan, Laser, Moore, & Shakrani, 1994), students not only are geographically illiterate, lacking essential knowledge, skills, and concepts of their physical and human environments, they also lack the ability to perform higher level cognitive thinking in geography (Patrick, 1993; Persky et al. 1996)

Efforts to strengthen geography education have been led by professional geography groups in areas of assessment, curriculum development, and teacher inservice; yet little has been done to examine how students think about geography (Carretero & Voss, 1994; Downs, 1994; Fernald, 1996; Gregg & Leinhardt, 1994). Despite this situation, the National Standards for Geography outline what students should know and be able to do to achieve a world-class standard of geographic competency (Stoltman, 1995). Therefore, investigations of students' thinking in geography are sorely needed (Downs, 1994; Forsyth, 1995).

Although the need to understand conceptual thinking is recognized (Armento, 1986; Hallden, 1994; Reif & Larkin, 1991), there is little research on students' understanding of geography concepts (Downs, 1994; Gregg & Leinhardt, 1994). "Based on our findings, we propose that instruction be oriented toward providing explanations that enable students to understand the concepts and events that make up the core of geography and history" (Beck, McKeown, & Gromoll, 1989, p. 153).

The purpose of this study was to investigate how students conceptualize geography. The major questions were: What concepts define the subject of geography for students? and How are those concepts meaningfully organized?

Theoretical Framework

Conceptual Thinking

Conceptual development is critical for student learning; moreover, researchers support the necessity of concept teaching for meaningful understanding (Greeno, Collins, & Resnick, 1996; Kuhn, Garcia-Milla, Zohar, & Anderson, 1995; Reif & Larkin, 1991). Concepts, the fundamental building blocks of cognition, are categories or hierarchies containing associations of ideas organized into schemas. As mental constructs, concepts are patterns of thinking which may be accessed according to an individual's motivation, prior learning, and reasoning skills.

Knowledge Domain. Researchers have found prior knowledge and experience within a domain determine students' depth of conceptual structures, which are only then generalized to other domains (Bereiter & Scardamalia, 1992; Leinhardt, 1992). Thus, students' competencies when they enter the classroom--their prior knowledge (background knowledge) combined with experience (reasoning skills)--are most critical to what they learn. Because conceptual thinking is domain specific, learning must be understood within each subject (Keys, 1995).

A knowledge domain consists of the specific content and strategies, the declarative and procedural knowledge, needed to learn in a subject (Bereiter & Scardamalia, 1992; Reif & Larkin, 1991). Declarative knowledge includes the concepts and propositions necessary to achieve particular goals, while procedural knowledge includes the actions, plans, and strategies (Jones & Idol, 1990).

Expertise. Concepts are individual constructions of meaning that develop into elaborate networks with a person's greater expertise in a domain. The patterned thinking of experts is their understanding of principles based on core concepts of a domain (Bransford & Vye, 1989). Expert studies have assisted identification of key concepts and strategies in a domain (Bransford & Vye, 1989). To understand how expertise is acquired, researchers have explored the gap between experts and novices including the domain of social studies (Spoehr, 1994).

Studies of knowledge acquisition assume children learn from adults; therefore, learning is measured by comparing children and adult understanding (Delval, 1994). Spoehr (1994) suggested students would think like experts if students organized their thinking like experts, which includes using concepts and conceptual relationships in a structural organization associated with expertlike reasoning (McGilly, 1994).

Conceptual Thinking in Geography

Researchers suggest the organizing concepts of a domain must be formally learned to acquire the habits of mind of the domain (Driver, Asoko, Leach, Mortimer, & Scott, 1994). Although conceptual knowledge along with problem-solving skills and metacognition forms the cognitive development characteristics of social studies learning (Alleman & Rosaen, 1991), conceptual understanding is not the most important element of reform in geography education as it is for science education (Eisenhart, Finkel, & Marion, 1996). The nature of social studies concepts may clarify the lack of emphasis on conceptual understanding. Social studies concepts are vague, abstract constructions without clear boundaries interconnected with other concepts in complex relationships (Spoehr, 1994). Moreover, they often lack a direct concrete reference as in the sciences and so are difficult to define (Hallden, 1994).

What concepts define geography are unclear. Textbooks, the basis of much curriculum, reflect no consensus in concepts or conceptual development (Beck et al. 1989; Haas, 1991). Textbooks and programs, which attempt to identify a K-12 sequence of concepts, are usually unsuccessful (Beck et al. 1989). Furthermore, researchers (Stein, Baxter, & Leinhardt, 1990) conclude that teachers with limited and poorly organized knowledge use few if any conceptual connections. Thus, neither the textbook nor the teacher typically represents or models the conceptual basis for students' understanding of abstract concepts in social studies classrooms (Beck et al.

1989). "A search for the generative ideas and concepts in each discipline could provide a principles basis for deciding among the many competing bits of knowledge that now fill textbooks and classrooms" (Resnick & Klopfer, 1989, p. 208).

The Five Fundamental Themes are the overarching concepts of K-12 geography programs in the United States (Gregg & Leinhardt, 1994). The Five Themes, which include location, place, movement, human-environment interaction, and region, form the basis of geography education. However, the Five Themes are not universally accepted because they are not considered a sufficient and representative conceptualization of geography (Gersmehl, 1992; Harper, 1992). Also, they are not designed as a scope and sequence or content of a geography course, but as a framework for teacher understanding of essential geography ideas (Bednarz, 1994).

Researchers (Armento, 1986; Gregg & Leinhardt, 1994; Martorella, 1991) agree that studies examining students' conceptual thinking in geography are lacking. In an annotated bibliography of geography education research, Forsyth (1995) concluded there was little theoretical research on geography learning and suggested research was needed on students' thinking. Furthermore, Piaget's developmental theories undergird much geography research, although these theories are considered conservative and being questioned. As a result, there is no consistent theory to investigate students' thinking in geography (Forsyth, 1995). It may be concluded the lack of research in students' thinking is a serious gap in geography education.

The necessity of exploring conceptual development corresponds with renewed interest in geography education and students' performance (Downs, 1994; Stoltman, 1995). Previous investigations applicable to geography education have shown the importance of prior knowledge and reasoning skills (Keys, 1995; Tytler & White, 1996; van der Schee, van Dijk, & van Westrhenen, 1992), and the value of combining declarative and procedural strategies (Keys, 1995; Means & Voss, 1996; van der Schee et al. 1992) for students' conceptual understanding. According to an ongoing geography study of seventh through tenth graders by van der Schee et al. (1992), students have few problems with declarative knowledge, but they have difficulty applying procedural knowledge. The researchers concluded these results may reflect the lack of focus on geography concepts, which confirmed their earlier research. Research has also provided evidence that conceptual development may be age related (Means & Voss, 1996; Tytler & White, 1996; van der Schee et al. 1992) or ability related (Markham et al. 1994; Means & Voss, 1996). Therefore, the role of achievement and grade needs further investigation.

Learning to reason geographically may be limited if students do not acquire the schema to remember geography information and concepts (Gregg, Stainton, & Leinhardt, 1990). Moreover, the necessity to teach geography concepts for a geographically literate population is clear (Gregg & Leinhardt, 1993). Geography instruction tends to be abstract and conceptual; therefore, students' performance within a grade may vary greatly based on the degree of abstraction and level of cognitive development (Downs, Liben, & Daggs, 1988). Gregg and Leinhardt (1994) propose teachers need understanding of both students' conceptual thinking and cognitive strategies to facilitate conceptual learning. Thus, a process to identify salient geography concepts and investigate student understanding of those concepts at different achievement and grade levels is necessary.

Theoretical Perspectives

Unification of Theories

Cognitive researchers are unifying theories to focus on processes of student understanding. By presenting commonalities among theories, researchers (Derry, 1996; Greeno et al. 1996; Reynolds, Sinatra, & Jetton, 1996) are exploring the multi-dimensionality of thinking and learning. Although educational theories can be identified and their unique contributions recognized, unification of theories may prove a valuable avenue to explore learning (Derry, 1996). Since educational theories are incomplete, each with particular weaknesses (Reynolds et al. 1996), unification of theories can strengthen perspectives and methodologies of learning.

Derry (1996) suggests that schema theory bridges theoretical perspectives of information processing and cognitive constructivism. This idea is potentially feasible because researchers (Cobb, 1994; Derry, 1996) recognize the need to unify theories, and schema theory is a major component of both perspectives.

Schema theory developed under the larger perspective of information processing which focuses on knowledge as organized patterns of cognitive structures and procedures. It entails a conceptual approach to learning in which complex networks of concepts are developed through specific cognitive strategies. Because students are active processors of information, concepts can be identified and cognitive skills can be taught to develop higher order thinking within a domain.

Constructivism focuses on construction of general conceptual understanding and thinking abilities through problem solving and reasoning tasks (Greeno et al. 1996). Constructivism has been the theoretical underpinning of most recent research on conceptual learning. In addition, constructivism suggests the importance of prior learning, cognitive strategies, and metacognitive processes to understand students' conceptual framework in a domain (Greeno et al. 1996; Keys, 1995). Furthermore, constructivism has aided understanding of conceptual development and learning strategies through investigations of student thinking (King, 1994; Osborne, 1996).

By unifying theoretical perspectives, the goal of understanding the development of student thinking can be more readily achieved. Moreover, since "school is largely about fostering gradual schema shifts, or developmental change over time" (Derry, 1996, p. 23), schema theory is a most appropriate bridge.

Schema is composed of hierarchical networks of prior knowledge which determines what is learned and how it is retained (Reynolds et al. 1996). Individuals construct new understanding based on the interaction of prior knowledge and new information. Information processors believe schema represents the underlying structure of memory. Constructivists believe conceptual understanding is based on constructed schema, and reflection of that schema "is the catalyst that brings about cognitive structuring and restructuring" (Derry, 1996, p. 9). Both information processing and constructivist perspectives "focus on procedures and operations for representing and reasoning about information. Learning is understood as a constructive process of conceptual growth, often involving reorganization of concepts in the learner's understanding" (Greeno et al, 1996, p. 16).

The unification of schema theory, embedded in information processing and constructivism represents a strong theoretical basis to an exploratory study of students'

conceptual thinking in geography. A single theoretical focus may dissect and analyze components of conceptual thinking, yet a unified theoretical focus may stimulate research of the components and their relations. Portraying a broad view of conceptual thinking is a first step towards understanding conceptual thinking within a domain.

Schema Theory

Concepts, the building-blocks of learning, organize ideas into patterns for deeper cognitive understanding and faster cognitive processing. Thus knowledge is not randomly organized; instead, it is arranged into patterns of concept clusters. The clusters of concepts and their interrelationships create schemata--the generalizations, principles, and rules of a domain.

Schema is an individually-constructed organization of thinking (Martorella, 1991; Torney-Purta, 1991) in which networks of concepts of differing salience are modified with incoming information that lead to reorganizing and restructuring (White & Gunstone, 1992). Schema constructions, thought to be hierarchical and in chunks to organize and simplify memory, are vital for comprehension and necessary to create meaning (Bereiter & Scardamalia, 1992; Greeno et al. 1996; Resnick & Collins, 1994; Torney-Purta, 1991). As individuals develop cognitively, they personally construct their schema formulating new categories and relationships from their perspectives. Thus, schema are not exact replicas of the world, but recreations of an individual's thinking (Bereiter & Scardamalia, 1992; Torney-Purta, 1991).

In social studies, schema are beneficial for comprehension, memory, and problem solving (Martorella, 1991; Torney-Purta,1991; Wilcox & Williams, 1990); moreover, schema theory could be applied to geography (Gregg et al. 1990). Investigators (Gregg et al. 1990; Torney-Purta, 1991) propose that the systematic study of geography creates schema to organize domain knowledge, which is needed for factual recall and for reasoning. Since the application of schema theory improves the meaningfulness of learning, strategies to enhance schema construction are vital.

Concept Mapping

Students' integrated patterns of knowledge or schemata are arranged intricately according to their understanding and may be accessed through use of concept maps (Torney-Purta, 1991). In theory, the external concept map represents the internal cognitive map (Shavelson, Lange, & Lewin, 1993). Therefore, through analysis of concept maps, students' thought processes (procedural knowledge) as well as their products (declarative knowledge) may be better understood (King, 1994; Novak, 1990; Shavelson et al. 1993; White & Gunstone, 1992).

A concept map is a graphic with concepts at each node and connecting lines to show relationships among concepts. A simple concept map of geography is shown in Figure 1. Concept maps illustrate students' understanding of conceptual relationships and may be reliably evaluated to show conceptual understanding (King, 1994; Markham, Mintzes, & Jones, 1994; Shavelson et al. 1993; Tamir, 1991; White & Gunstone, 1992). The quality of a student's understanding can be identified by the quantity and nature of relations between the elements of knowledge--propositions which connect concepts. The created pattern is interpreted as representative of the conceptual organization of the mapmaker and the content of a domain (Markham et al.

1994; Shavelson et al. 1993; Tamir, 1991; Torney-Purta, 1991). Concept maps, then, are representative models of students' understanding of a domain.

Concept mapping has been used as a tool for curriculum development, instructional design, evaluation and assessment, metacognition, and research at elementary, secondary, and college levels for the past 20 years (Markham et al. 1994; Novak, 1990; Shavelson et al. 1993; Tamir, 1991). A meta-analysis of 19 concept mapping studies in science education (Horton, McConnell, Gallo, Woods, Senn, & Hamelin, 1993) concluded concept mapping has a positive effect on achievement and attitude and, as an organizational tool, promotes learning. In addition, Novak and Musonda's (1990) 12-year study in science found evidence of concept mapping's usefulness in learning. Other concept mapping research has also shown positive effects with attitude, learning, and metacognition (Markham et al. 1994; Novak, 1990; Shavelson et al. 1993; Tamir, 1991; White & Gunstone, 1992).

A study by Markham et al. (1994) compared nonmajor and major biology students' conceptual understanding through concept mapping. The investigators modified the Novak and Gowin (1984) scoring technique to identify and evaluate concept map components. Points were given for the number of concepts, propositions, hierarchies, branches, cross-links, and examples. Results indicated differences in the structure and complexity of constructed concept maps were based on students' domain knowledge; maps of majors were more complex, extensive, and integrated than maps of nonmajors. The researchers concluded concept maps and concept map components validly represent the depth of students' conceptual thinking.

Concept map construction combined with interviews may assess students' declarative and procedural knowledge of a subject (White & Gunstone, 1992). Concept maps may be examined, then, to understand what students know and how they think about a subject (White & Gunstone, 1992).

Methods of the Study

Approach

A mixed methodology approach combines quantitative and qualitative methods in an integrated methodological perspective (Creswell, 1994). Mixed methodology not only utilizes advantages of both methods, it also includes deductive and inductive strategies, which are reflected in the ongoing constructive dialogue of the researcher with the study. This flexible process of deduction and induction can be used successfully when investigating conceptual understanding (Creswell, 1994).

Mixed methodology yields triangulation procedures which entails convergence of results, providing a strong basis for analysis. Moreover, researchers (Keys, 1995; van der Schee et al. 1992) have successfully used triangulation to investigate students' conceptual thinking. Multiple triangulation, the linking of multiple theories, methods, and data in an investigation reduces the limitations of single theories, methods, and data and increases the strength and depth of interpretation (Denzin, 1994). Moreover, multiple triangulation is the preferred strategy for investigations in the social studies (Brophy, 1995; Denzin, 1994).

This study used multiple triangulation of theory, methods, and data to explore students' conceptual thinking in geography. The three central questions of this

exploratory study were the following:

1. What is the relationship between achievement levels and grade levels with regards to performance on the geography knowledge instrument?
2. What is the relationship between achievement levels and grade levels with regards to identification and use of salient geography concepts?
3. What is the relationship between achievement levels and grade levels with regards to the complexity of students' concept maps?

An extensive pilot study using students, expert geographers, and dissertation readers modified and clarified instructions and instruments for this study. Detailed procedures of methodology are reported elsewhere (Trygestad, 1997).

Context

To explore students' conceptual thinking, 66 students from a predominately middle class, suburban school district in the Midwest, were invited to participate. Sixth, ninth, and twelfth graders were invited to participate because they had completed a geography course the previous year. To clearly delineate academic achievement levels, students were placed in one of four groups based on their final course grade in geography the previous year: low (D+, D, D-), average (C, C+, B-, B), high (A-, A), and transition (C-, B+). To reduce classification errors, students in the transition group, whose grades were not clearly at one achievement level, were not considered. After placement in one of nine groups, students were selected through a stratified random sampling procedure from each achievement level at each grade level using a table of random digits. At least seven students from each achievement level (low, average, high) at each grade level (6th, 9th, 12th) participated.

To identify concepts, authors and committee chairs of the National Geography Standards were invited to identify salient concepts from the Standards document. An original list of 40 concepts was generated through examination of the Standards from which the experts could select or add additional concepts. Agreement by four of the eight experts who responded created a list of 25 salient geography concepts which was used for this study. In addition, the experts were asked to demonstrate their understanding of geography by arranging the selected concepts in a concept map. Altogether, eight of fifteen invited experts completed the task to identify salient geography concepts and seven constructed a concept map. The researcher considers their efforts a valuable perspective of expert thinking in geography and a reflection of the underlying conceptual framework of the Standards.

Procedures

Students began by completing the Student Information with background questions. Next, students answered the Geography Knowledge Questions, an instrument with ten multiple-choice questions from the 1994 National Assessment of Educational Progress of Geography (NAEP) to assess their background knowledge.

The complex question of how students think conceptually was examined using several methods. Students identified familiar concepts from the list of 25 Geography Concepts and validated their concept identification in a brief card sorting process to separate familiar from unfamiliar concepts. Next, concept mapping was explained using two examples. The concept maps, Living Things (White & Gunstone, 1992) and

Earth (Martorella, 1991), were selected because they illustrated the process and complexity of concept mapping; they also were familiar topics for students and appropriate to geography. Students constructed a concept map of geography using cards identified with familiar concepts. The map was replicated on paper and connecting lines and words were added. Students were asked to explain the map and its connections. The semi-structured individual interview explored and clarified students' responses using closed- and open-ended questions designed to elicit responses of the map construction process and students' thinking about geography, geography concepts, and geography learning.

Scores from instruments and comments from interviews were compiled and compared across achievement and grade levels. The background questions provided information on attitudes toward geography and travel experience. A final score from the geography questions assessed students' background knowledge. Concept maps were scored using the procedure outlined by Markham et al. (1994) in which each concept map component was scored separate; a final map score was also tabulated. Data from the instruments was analyzed using a 3 X 3 design and an analysis of variance (ANOVA) procedure to examine students' conceptual thinking across achievement and grade levels. Descriptive statistics were used to analyze patterns of students' responses. The audio tape of each interview was transcribed verbatim. Comments were compiled and categorized into 12 overlapping categories which were examined for patterns and generalizations regarding students' beliefs and attitudes.

Results of the Study

Results of this study indicate students' conceptual thinking in geography is reflected in their achievement and grade levels. Other variables may be important contributors to students' conceptual thinking, but those were not investigated. Results of ANOVAs indicate not only increased conceptual understanding with increased achievement and grade levels, but also with increased performance on background knowledge, concept identification, and concept map construction instruments. Correlations among knowledge questions, number of concepts, and concept mapping scores were also statistically significant. In addition, attitude towards geography was statistically significant for achievement and grade; travel experience was statistically significant for achievement.

Background Knowledge

The first central question of this study was: What is the relationship between academic achievement levels and grade levels with regards to performance on the geography knowledge instrument. Students' background knowledge was determined by their composite score of correct answers on the Geography Knowledge Question instrument. Results of the one-tailed analysis of variance were statistically significant for both grade ($F(2,57) = 12.18$, $p < .01$) and achievement ($F(2,57) = 9.31$, $p < .01$). However, the interaction of grade with achievement was not statistically significant.

Means and standard deviations were calculated to determine background knowledge at each achievement and grade level. Results reveal students who performed better on the selected NAEP questions tended to be at higher achievement

and grade levels. That is, students at the high achievement level tended to perform better on the Geography Knowledge Questions instrument than students at average or low achievement levels, and students at the average level tended to perform better than students at the low achievement level. Also, twelfth grade students tended to perform better on the Geography Knowledge Questions instrument than ninth or sixth graders, and ninth graders tended to perform better than sixth graders.

Students' responses to individual questions were explored through interviews in which they briefly commented on their answers. Incorrect responses may have been due to alternative conceptions, inaccurate factual knowledge, interpretation of questions, context of prior knowledge, or incorrect guess or deduction.

Concept Identification

The second central question of this study was: What is the relationship between academic achievement levels and grade levels with regards to identification and use of salient geography concepts. Both identification of total number of concepts as well as identification of individual concepts reflect students' achievement and grade levels. The number of salient concepts students identified and used increased with grade and achievement from 3 concepts (sixth grade low achievement) to 25 concepts (twelfth grade high achievement). Results of an ANOVA indicate statistical significance with grade ($F(2,57) = 19.73$, $p < .01$) and achievement ($F(2,57) = 10.60$, $p < .01$). However, the interaction of grade and achievement was not significant.

Descriptive statistics of individual concept identification and use reflect patterns of achievement and grade; the level of concept difficulty for students was determined by the frequency of concept identification. Although no concept was identified and used by 75% of all students at every achievement and grade level, particular concepts were more frequently identified and used. Location was identified and used by 96% of students; culture was identified and used by 89% of students; and environment was identified and used by 86% of students. These three concepts–location, culture, and environment--were identified by students as the most valuable concepts to the study of geography. Moreover, students used these concepts frequently in their definitions and explanations of geography. Other familiar concepts were latitude & longitude (88%), map (94%), place (80%), population (89%), and region (82%), which were identified and used by the majority of students at each achievement and grade level.

The Five Themes, considered the organizing concepts of geography education (Gregg & Leinhardt, 1994; Hardwick, 1995), were identified by experts as salient concepts and included on the list of Geography Concepts. Students' identification and use of the Five Themes concepts varied. Students understood the concept of location (96%), place (80%), and region (82%), but had more difficulty identifying and using movement (49%) and interaction (44%). Identification and use of interaction reflected an increase in achievement and grade levels, which the other Five Themes did not reflect. Interaction is not only one of the Five Themes which organizes geography education, it also was the only concept, along with space, identified by all experts as salient to geography. Because interaction is a salient geography concept recognized by experts and reflects students' achievement and grade, further investigation of students' conceptual thinking with specific concepts, particularly interaction, is needed. In addition, location was a unique concept. It was identified and used by 96% of

students; no other concept had a higher percentage of familiarity. Moreover, location was the most frequently cited valuable concept by students of all achievement and grade levels. Thus, the concept of location dominates students' thinking of geography across achievement and grade levels in this study.

Concept Maps

The third central question of this study was: What is the relationship between academic achievement and grade levels with regards to the complexity of students' concept maps? The strategy of concept mapping was used to explore students' conceptual thinking, with greater complexity of concept map construction indicting greater complexity of conceptual thinking. The map score was statistically significant for grade ($F(2,57) = 14.60$, $p < .01$) and achievement ($F(2,57) = 6.02$, $p < .01$). However, the interaction of grade and achievement was not statistically significant.

The range of performance on concept map construction, which can be clustered into three groups, increased with achievement and grade levels. Sixth grade students and ninth grade low achieving students formed one cluster. Students' ability to understand and construct concept maps tended to increase with ninth grade average and high achieving students and continue with twelfth grade low and average achieving students. Twelfth grade high achieving students formed the third cluster of students. These students had the greatest average mean and standard deviation. Thus, concept maps reflect the complexity and elaboration of students' thinking with increased achievement and grade levels, from sixth grade low achieving students (M=49.14, SD=18.43) to twelfth grade high achieving students (M=171.57, SD=68.30).

Concept map components, which indicate the complexity of map construction, are: number of concepts, propositions, hierarchies, cross-links, examples, and branches. Except for examples, the components were statistically significant for correlations with students' background knowledge. In addition, the components, except cross-links and examples, indicate positive relationships with students' achievement and grade levels. Few students offered examples; this may be explained by the absence of examples in the concept maps provided as models for students' construction. Of those students who used examples, no patterns were identified; low achieving students provided examples as frequently as high achieving students; sixth grade students provided examples as frequently as twelfth grade students.

Geographic Expertise

Constructing a criterion concept map, an organizing tool for the domain, proved difficult. Experts identified few concepts or all concepts as valuable from the original list of 40 concepts. Experts also added concepts creating a range of 9 to 68 concepts; however, some experts identified skills, such as organizing and analyzing. Moreover, only two concepts, interaction and space, were identified by all experts. Although the Five Themes are considered foundational to geography education (Gregg & Leinhardt, 1994; Hardwick, 1995), experts did not unanimously identify them as salient.

Experts' maps, scored as students' maps, reflected students' scores. First, no expert included examples. Experts used the same provided concept map models as students; neither model contained examples. Second, the number of cross-links, which represents integrated knowledge structures, varied. Although one expert had

64 points for cross-links, four experts had none. Third, total map scores ranged from 48 to 307 for experts, which was a similar range for students (21-305) who were of three achievement and grade levels. Finally, experts' map scores (N=7, M=172, SD=130) were comparable to high achieving twelfth graders (N=7, M=172, SD=68). As a result, experts' maps were not averaged to create a criterion map. Constructing an expert map is still in the future (Bereiter & Scardamalia, 1992).

Attitude and Travel

Students' attitude toward geography and extent of travel were Likert-scaled with four possible responses and compiled for achievement and grade. Most students thought geography was "Good" (56%) or "Okay" (24%); few students thought geography was "Great!" (14%) or "Boring" (6%). Students' travel experience went beyond the surrounding states of Minnesota (100%). About 44% of students said they had traveled outside the United States.

Attitude towards geography and travel experience yielded significant results. Attitude towards geography was statistically significant for both achievement and grade. Although students who traveled outside the United States tended to have more positive attitudes toward geography than students who had not traveled outside the United States, this was not statistically significant. In addition, travel tended to be more extensive for students of higher achievement and grade levels. Twelfth graders not only had more experiences, they had more opportunities for travel through participation in sports, church, and group activities; however, results were not statistically significant for grade. High achieving students tended to travel as much or more than low achieving students; results were statistically significant for achievement.

Students' Responses to Geography, Geography Concepts, and Geography Learning

Students' interviews were transcribed verbatim and statements were categorized into 12 multiple-response and nonexhaustive categories through a data reduction process to identify patterns of responses (Behrens & Smith, 1996; Creswell, 1994). Students' responses to geography, geography concepts, and geography learning, were significant topics for this study of students' conceptual thinking.

Geography. Students' responses toward geography were based on the topics, activities, instruction, and teacher. Students' descriptions of geography were mixed: "Not boring. Not good" (ninth grade low achievement). Geography was described as didactic with few activities. "It just gets tedious. It doesn't change at all. Just the information and sometimes the way I learn it" (ninth grade average achievement).

> It's not my favorite and last year I thought it was pretty boring. I just sat there and we were reading and sometimes like I would start day dreaming and, cause I didn't like it much last year, but I think it's much better this year....Well, we did a couple projects and those were okay, but most of the time we just sat there and read and answered questions out of a book and we didn't do much (sixth grade low achievement).

Students viewed geography learning as the acquisition of geographic literacy. Some students described geography as making maps or knowing locations and, therefore, considered the subject of limited use. When asked to explain "What does geography

mean to you?" a student responded, "I don't know! Just like what the earth is like. Continents and countries and states and knowing where they are and stuff like that" (ninth grade high achievement). "All we did was we say we knew what continent Africa's on. I mean. Africa's a continent. I know that! But! It was like questions like that. And then. Okay! (ninth grade low achievement). Some students suggested the need to increase geography learning. "Geography's like part of everything you do." The twelfth grade high achieving student explained further: "I don't know, I just know that it's an important subject. And it's very. I'm very involved in it, I guess. In our own lives. You know. It's just very powerful."

Students explained that geography was a class at the middle school and an integrated subject at the high school. For example, a senior suggested geography was necessary for younger students to learn location information, but for high school-aged students other classes were more interesting and valuable.

> Yah, it's good to know where things are, but I don't think it needs to be pushed on people. Don't say that you have to take this class or things like that. At a younger age it's better just, you know, if you watch the news and then, you go oh, where's that place. I don't know where that is That's a good reason to take it. but as far as later on in high school and things like that, people are more interested in--like I'm taking a criminology class now and psychology class--they're more interested in those kinds of social studies rather than where things are in the world (twelfth grade average achievement).

Students across achievement and grade levels had mixed responses toward geography. Student's attitude toward geography was related to how comfortable they were acquiring location and map skills and how exciting the learning process was when acquiring literacy.

Geography Concepts. Students focused on concepts and concept mapping as a stimulating process as well as a challenging activity. Students did not mention the Five Themes or organize their concept map according to the Five Themes. Students tended to address how they learned concepts by focusing on how concepts were taught. A twelfth grade high achieving student explained how concepts were taught. "Most of them without mentioning those names, yes, not much, not much on the terms ....They talked about the ideas without labeling it." Another senior (high achievement) expressed concern that concept learning be available for all students.

> My experiences when I was a sophomore--I took just regular U.S. history. And we did a lot of facts and dates, so to speak. I mean we certainly talked about concepts and reasons of why things happened, but it seemed like more and more it was just we went through the facts of the situation. But then in my AP European history we focused a lot more on concepts and I think I got more out of that. So I don't know if they are trying to make it where they feel only advanced students in advanced classes should be getting the concepts. But I think a concept is more important for everyone to learn on the whole, instead of just confining it to your AP classes.

A ninth grade high achieving student said concepts should be taught more often. "Yah, I think that. I mean people won't remember facts. They'll remember concepts; they're easier to remember." A twelfth grade low achieving student concurred. "You

get more into it, such as concepts. It makes your brain think a little more." Two ninth grade average achieving students thought concept learning was valuable. "Concepts are important to better understand geography. The class provided the concepts and linkages." "Concepts helped me think more. They gave me different ideas. There are so many things that make up geography. It's hard to narrow it down. They made me think more. Doing the map and looking at the concepts."

Most sixth graders (87%) were unfamiliar with concepts. Their introduction to concepts resulted in mixed responses with most agreeing concepts challenged their thinking. For example, an average achieving sixth grader said, "To me, facts are more fun. [Concepts] makes you think about different things that, like I wasn't thinking about."

Concept mapping was difficult. A ninth grade average achieving student said: "It was kind of like a test. Like a contest of what I knew and if I could connect it. And it was because it brings out my own resources and showing them." A twelfth grade low achieving student was confused and frustrated with concept mapping.

> It was kinda confusing. I guess when you have to take the words and then put it in and get it to make sense. It's kinda. I don't know. Kinda confusing sometimes. If makes you think the whole time. You can't just put the words there. You had to think about it for awhile.

Despite the challenge of construction, students felt mapping was valuable. They mentioned their thinking was challenged and they were able to review their understanding. "It shows how you think" (sixth grade low achievement). "Helped you think and add thought to your before thoughts" (ninth grade low achievement). "It just made me think that there's more to geography than just for what most people think it is--land regions...It helped me think about it, you know, but I knew it, you know. It was just subconscious. It just helped to bring it to mind" (twelfth grade average achievement).

Concept maps were described as visual models of students' thinking. "You can use it as a model, maybe, for your own thinking" (twelfth grade low achievement). Students compared concept mapping with a food chain or web, flow chart, hierarchy, chart, pyramid, and outline.

Students also evaluated concept mapping as a metacognitive strategy. A ninth grade low achieving student explained how mapping assisted thinking of geography.

> It helped me. It makes me examine geography a little more and what it's made up of instead of just taking a map and then you draw or do whatever to find stuff....This exercise changed my thinking about certain things and it didn't really teach me anything new. It just helped me realize that I know a little bit more, or something like that. It made me use my knowledge a little more.

"It was kinda hard. It really made me think. But it made me think twice about what I knew and didn't know....Yah, it helps me because it makes me evaluate what I'm thinking and why I'm thinking it" (twelfth grade low achievement).

> I haven't done a concept map until this year. And a concept map for me would show growth. It shows like where you've been and sort of like what you've learned yourself, also....It's a way for you also to put your thoughts in an order.... This helps you organize them and put them in sort of categories. It's an easier learning tool (twelfth grade average achievement).

Concept maps were considered valuable by most students. They felt concept maps were visual models that organized and replicated their thinking. As a tool for

clarification, concept mapping was a helpful metacognitive strategy. Through their brief encounter with concepts and concept maps, students responded positively and suggested continued emphasis on them in the classroom. Although students may have been challenged by the process of concept identification and use, they tended to find the conceptual orientation helpful and map construction valuable to understand geography.

Geography Learning. The most frequent responses about learning were enjoyment of activities and projects. Students felt they learned more and understood better when they were able to do something. Furthermore, students desired a greater focus on learning strategies and critical thinking.

> I think that you can make it a little more fun in class so kids, um, aren't as bored as they would seem to be. Because you see kids sitting there and they are listening to their teacher, but they don't really pay any attention very well and they don't ....So I think it would be a little better if they made it more fun like having activities (sixth grade low achievement).

A twelfth grade low achieving student said teachers expect students to connect ideas. "Um, it seems like they want you to do your own critical thinking or whatever they call it. Just. If I don't have to do, I won't. So I think they should help us out with it." He also suggested the need for more examples because learning is challenging. "Yah, to make stuff click. To just get your thoughts flowing in a certain way. Just needs a little prodding." Another senior (high achievement) explained how he had a better, deeper understanding of geography because he knew concepts. "Because we've actually thought about these things. And, we have classmates that don't even care....They don't think about things. All they think about is the next date...."

Students commented about classroom learning in general. A high achieving ninth grader said, "Stuff we learn in classes, it's never going to help us in life. It's never going to come up again." Another ninth grader (low achieving) explained how learning was not in depth or valuable and rarely had hands-on activities. "Well, see, it makes it more fun when you have hands-on projects....Yah, they keep teaching the same thing almost every year."

Students desire active and stimulating classroom lessons to challenge their thinking. Geography is perceived to have limited use by students if its focus is only knowing locations and reading maps.

Discussion and Conclusion

Findings

Results of this study indicate students' conceptual thinking in geography varies according to their academic achievement and grade levels. Students' background knowledge, concept identification, and concept map construction were positively related to their academic achievement and grade levels.

Geography Knowledge. The first central question of this study was: What is the relationship between academic achievement levels and grade levels with regards to performance on the geographic knowledge instrument? The study found students'

background knowledge was statistically significant for achievement and grade levels. Students of higher achievement and grade performed with higher scores on the background knowledge instrument than students of low achievement and grade levels. Thus, background knowledge in geography may be based on achievement and grade, which supports other research (Keys, 1995; Tytler & White, 1996; van der Schee et al. 1992).

According to the results of this study, background knowledge, as determined by total score on ten NAEP questions, and concept identification, the number of familiar expert-referenced geography concepts, are statistically related. Therefore, this study tends to support previous research which concluded that the amount and organization of prior knowledge aids conceptual development (Kuhn et al. 1995; Torney-Purta, 1994). Students in this study acquired geographic literacy and understood salient geography concepts based on their academic achievement and grade levels.

Conceptual Thinking. The second central question of the study was: What is the relationship between academic achievement and grade levels with regards to identification and use of salient geographic concepts? Both achievement and grade were found statistically significant for the number and kind of identified concepts.

Students of higher achievement and grade levels identified more concepts as familiar than students of lower achievement and grade levels. This finding supports other geography research (Means & Voss, 1996; van der Schee et al. 1992). A wide range of identified concepts existed across achievement and grade except among twelfth grade high achieving students. Also, the concepts more frequently identified represent achievement and grade levels. Sixth graders and low achieving students identified concrete concepts such as latitude & longitude, location, and map as familiar concepts. Twelfth graders and high achieving students identified concrete concepts as well as abstract concepts such as interaction, settlement, and spatial organization as familiar concepts.

A tentative conclusion of students' conceptual thinking in geography is that although both achievement and grade levels are statistically significant for concept identification and use, grade is statistically significant for concept identification and use for lower grades, but achievement is more important for both lower and higher grades according to t-test results. This supports previous research by Tytler and White (1996). However, this conclusion is based on the current study of what students have learned, not what students could learn. Achievement and grade may prove negligible when patterns of curriculum or instruction are modified, when students' background characteristics are varied, when achievement level is determined differently, or when home or school variables are considered.

Conceptual Organization. The third central question of the study was: What is the relationship of academic achievement and grade levels with regards to the complexity of students' constructed maps? Students' graphic representations of their conceptual thinking became more complex and elaborate with increased achievement and grade levels as indicated in the total concept map scores. Achievement and grade, then, are statistically significant for effective use of concept mapping as a strategic tool for conceptual thinking. However, results of t-tests indicate grade may be

a more important indicator than achievement for the complexity of map construction.

The complexity of students' concept maps indicated by total concept map scores was statistically significant for the extent of background knowledge and identification of concepts. Therefore, students' concept map scores tended to reflect their conceptual thinking in the domain, which supports earlier research (Horton et al. 1993; Markham et al. 1994; Novak & Musonda, 1991; Spoehr, 1994; Tamir, 1991; White & Gunstone, 1992). Students' conceptual thinking in geography, then, is related to their background knowledge, concept identification, and concept organization according to their academic achievement and grade levels.

Implications of the Study

Students' identification and organization of salient geography concepts were related to their achievement and grade levels and the extent of their background knowledge. Thus, conceptual thinking in geography can be enhanced with a framework which determines salient concepts, identifies learning strategies, and assesses background knowledge to facilitate students' conceptual thinking throughout a geography program. As Greeno et al. (1996) suggest, curriculum organization should be based on conceptual development rather than general cognitive development. The deep understanding of central concepts should be a central goal for meaningful learning in geography (Gregg & Leinhardt, 1993; Resnick & Klopfer, 1989; Roth, 1994). Therefore, an articulated concept based program within a sequential K-12 curriculum may prove valuable (Thornton & Wenger, 1990).

Identification of Salient Concepts. Salient geography concepts, identified as a result of this study, should be introduced in the elementary years and extended throughout the secondary years. The findings of this study indicate students can understand concrete and abstract concepts at an elementary age, although perhaps with varying degrees of breadth and depth. Moreover, students were able to organize the concepts into a hierarchy given the concept map strategy; therefore, salient concepts which organize the domain should be identified with supporting concepts.

Students should be introduced to the organizing concepts of the domain in the elementary years. The Standards identified people, places, and environment as salient concepts which organize the domain. Students in this study identified culture, location, and environment as defining concepts. Thus, these concepts are organizers of the domain from which generalizations, skills, and perspectives can be drawn.

Care must be taken that neither the Five Themes nor the Standards are dismissed as inadequate to organize students' conceptual thinking. The Five Themes, embedded in generalizations of the Standards, provides a conceptual framework for educators to organize their thinking of the domain. Brophy (1990) suggests geography should be based on the examination of conceptual relationships; networks of concepts and generalizations organize the domain for meaningful understanding. Therefore, a conceptual focus which includes, but is not limited to, the Five Themes is necessary (Hardwick, 1995).

The Standards outlines generalizations with embedded concepts for each grade cluster. How teachers apply the generalizations and related concepts depends on their professional background and instructional tools (Stein et al. 1990). According

to Downs (1994), geographers are seeking lessons to apply the Standards to the classroom. Teachers in collaboration with teacher-trainers can develop these lessons. Such engagement would enhance their professional development, model educational partnership, and aid other educators. The dissemination of Standards-based lessons is critical for the geography education reform movement.

Identification of Learning Strategies. Geography lessons need to combine declarative and procedural knowledge in order to facilitate students' fundamental understanding of concepts and enhance meaningful learning (Keys, 1995; Means & Voss, 1996; van der Schee et al. 1992). Metacognitive strategies are needed to link declarative and procedural knowledge because they are not meaningfully linked in the social studies (Brophy, 1990). The metacognitive strategy of concept mapping was found valuable by students in this study to assess their conceptual thinking and found reliable by the researcher to identify student's conceptual organization. In addition, concept maps may be reliably scored using concept map components to assess the complexity of students' conceptual thinking.

Assessing Prior Knowledge. Assessments of students' background knowledge and concept identification prior to instruction are necessary to determine appropriate levels of instruction. In addition, assessments throughout the learning process are needed. In this study, a multiple choice test was found valuable to assess students' background knowledge; other assessments can be developed.

Methods to assess conceptual thinking in this study included an objective instrument, a strategic tool, and an individual interview. Classroom assessment also needs to be multi-dimensional and constructed (Brophy, 1990). That is, multiple assessments (using more than one strategy) and alternative methods (using non-paper and pencil methods) can be used to evaluate students' conceptual thinking.

Dialogue within an assessment framework should be considered part of the geography classroom. Discussions are valuable to expose conceptual understanding and encourage metacognition (McGilly, 1994). Interviews can also illustrate students' declarative and procedural knowledge (White & Gunstone, 1992).

Implications for Research.

Results of the literature review and findings of this exploratory study present ideas and raise questions for future research. Conceptual thinking is a broad area and suggested research can only highlight some areas for investigation.

A longitudinal study is necessary to investigate conceptual development. This study identified differences in conceptual thinking by achievement and grade levels, but conceptual thinking over time should be examined. In addition, in-depth case studies of individual students over an entire geography program are needed to explore the development of conceptual understanding. Whether students reach a plateau of understanding in the middle school years as they synthesize more abstract concepts in new situations needs to be explored (Tytler & White, 1996). Consideration of other variables such as the teacher, text, motivation to learn, and impact of other disciplines is needed. A study to assess the development of individual geography concepts would also be valuable.

Further investigation of students' concept identification is needed to determine students' selection of concepts. If concepts were generated by students instead of expert-referenced, what concepts would be identified and how would students' concept maps be organized? Also, an investigation of the application of conceptual thinking to problem solving situations would extend the research base of conceptual understanding. Researchers have explored reasoning in other domains (Tytler & White, 1996; Wigfield et al. 1996) and in geography (van der Schee et al. 1992), but students' geographic reasoning needs further investigation.

Concept mapping is a valid metacognitive strategy, but the strategy needs further investigation to clarify and standardize its use. Conduct a pre- and post-instruction experiment to assess conceptual thinking through mapping. In addition, concept mapping as a metacognitive tool was understood by students in this study with only a brief introduction. If students had more exposure to concept mapping how would their map construction vary? Also, a comparison of concept mapping with other strategies is vital. How do concept maps measure students' understanding in similar or different ways than other strategies? Additional studies are also needed to confirm and standardize the concept map components and the scoring rubric.

Results of this study were not definitive and follow-up studies may yield statistically significant results when variables are more sharply-defined. This study captured a moment in time and generalizes to a particular population which, as a result, raised some interesting questions.

Conclusion

The objectives of this study were to explore students' conceptual thinking in geography by asking: What concepts define the subject of geography for students? and How are those concepts meaningfully organized? This study determined that background knowledge, familiar concepts, and the complexity of concept organization provided insights into students' conceptual thinking according to their academic achievement and grade levels. Furthermore, according to students' responses, they desire a greater focus on conceptual thinking for meaningful learning in geography.

This study made an important contribution to geography education and to current scholarship on conceptual thinking. It complements previous research and provides important insights into conceptual thinking. It also confirms that conceptual thinking is a valuable component of learning and the concepts students know and how they organize them within a domain is a critical aspect of their learning.

This study is particularly relevant as teachers and curriculum developers align classroom practice with national and state standards. Conceptual thinking may become a prominent element of curriculum revision and instructional training. Furthermore, students are active constructors of meaning based on their complex conceptual structure, or schema, which need to be challenged and extended.

References

Alleman, Janet Elaine & Rosaen, Cheryl L. (1991). The cognitive, social-emotional, and moral development characteristics of students: Basis for elementary and middle school social studies. In James P. Shaver (Ed.), Handbook of Research on Social Studies Teaching and Learning (pp. 121-133). New York: Macmillan Publishing Company.

Armento, Beverly (1986). Research on teaching social studies. In M.C. Wittrock (Ed.), Handbook of Research on Teaching (pp. 942-951). New York: Macmillan Publishing Company.

Beck, Isabel L., McKeown Margaret G., & Gromoll, Erika W. (1989). Learning from social studies texts. Cognition and Instruction 6(2), 99-158.

Bednarz, Robert S. (1994). National standards in geography are coming. Journal of Geography 93(2), 105-106.

Behrens, John T. & Smith, Mary Lee (1996). Data and data analysis. In David C. Berliner & Robert C. Calfee (Eds.), Handbook of Educational Psychology (pp. 945-989). New York: Macmillan Publishing Company.

Bereiter, Carl & Scardamalia, Marlene (1992). Cognition and curriculum. In Philip W. Jackson (Ed.), Handbook of Research on Curriculum (pp. 517-542) New York: Macmillan Publishing Company.

Bransford, John D. & Vye, Nancy J. (1989). A perspective on cognitive research and its implications for instruction. In L.B. Resnick & L.E. Klopfer (Eds.), Toward the Thinking Curriculum: Current Cognitive Research. Washington, D.C.: Association for Supervision and Curriculum Development.

Brophy, Jere (1990). Teaching social studies for understanding and higher order application. Elementary School Journal 90(4), 351-417.

Brophy, Jere (1995). Thoughts on the qualitative-quantitative debate. Paper presented at the annual meeting of the National Council for the Social Studies. (ERIC Document Reproduction Service No. ED 392 734).

Carretero, Mario & Voss, James F. (1994). Cognitive and Instructional Processes in History and the Social Sciences. Hillsdale, NJ: Lawrence Erlbaum Associates.

Cirrincione, Joseph M. & Farrell, Richard T. (1988). The status of geography in middle/junior and senior high schools. In Salvatore J. Natoli (Ed.), Strengthening Geography in the Social Studies (pp. 11-21). Washington, D.C.: National Council for the Social Studies.

Cobb, Paul (1994). Constructivism in mathematics and science education. Educational Researcher 23(7), 4.

Creswell, John W. (1994). Research Design: Qualitative & Quantitative Approaches Thousand Oaks, CA: SAGE Publications.

Delval, Juan (1994). Stages in the child's construction of social knowledge. In Mario Carretero & James F. Voss (Eds.), Cognitive and Instructional Processes in History and the Social Sciences (pp. 177-102). Hillsdale, NJ: Lawrence Erlbaum Associates.

Denzin, N.K. (1994). Triangulation in educational research. In Torsten Husen & T. Neville Postlethwaite (Eds.), The International Encyclopedia of Education (2nd ed.) (pp. 6461-6466). Tarrytown, NJ: Pergamon Press.

Derry, Sharon J. (1996). Cognitive schema theory in the constructivist debate. Educational Psychologist 31(3/4), 163-174.

Downs, R.M. (1994). The need for research in geography education: It would be nice to have some data. Journal of Geography 93(1), 57-60.

Downs, Roger M., Liben, Lynn S. & Daggs, Debra G. (1988). On education and geographers: The role of cognitive developmental theory in geographic education. Annals of the Association of American Geographers 78(4), 680-700.

Driver, Rosalind, Asoko, Hilary, Leach, John, Mortimer, Eduardo, & Scott, Philip (1994). Constructing scientific knowledge in the classroom. Educational Researcher 23(7), 5-12.

Eisenhart, Margaret, Finkel, Elizabeth, & Marion, Scott F. (1996). Creating the conditions for scientific literacy: A re-examination. American Educational Research Journal 33(2), 261-295.

Ericsson, K. Anders & Simon, Herbert A. (1993/1984). Protocol Analysis: Verbal Reports as Data (Rev. ed.). Cambridge, MA: The MIT Press.

Fernald, Edward A. (1996). The need that just won't go away. Journal of Geography 95(1), 2-4.

Forsyth, A. (1994). Learning Geography: An Annotated Bibliography of Research Paths. Indiana, PA: National Council for Geographic Education.

Geography for Life: National Geography Standards (1994). Washington, D.C.: National Geographic Research & Exploration.

Gersmehl, Philip J. (1992). Themes and counterpoints in geographic education. Journal of Geography 91(3), 119-123.

Greeno, James G., Collins, Allan M., & Resnick, Lauren B. (1996). Cognition and learning. In David C. Berliner & Robert C. Calfee (Eds.), Handbook of Educational Psychology (pp. 1-46). New York: Macmillan Publishing Company.

Gregg, Madeleine & Leinhardt, Gaea (1993). Geography in history: What is the where. Journal of Geography 92(2), 56-63.

Gregg, Sister Madeleine & Leinhardt, Gaea (1994). Mapping out geography: An example of epistemology and education. Review of Educational Research 64(2), 311-361.

Gregg, Madeleine, Stainton, Catherine, & Leinhardt, Gaea (1990). Where is Geography? Three Studies of Thinking and Teaching (Technical Report No. CLIP 90-04). Pittsburgh, PA: University of Pittsburgh Learning Research and Development Center.

Hallden, Ola (1994). Constructing the learning task in history instruction. In Mario Carretero & James F. Voss (Eds.), Cognitive and Instructional Processes in History and the Social Sciences (pp. 187-200). Hillsdale, NJ: Lawrence Erlbaum Associates.

Haas, Mary E. (1991). An analysis of the social sciences and history concepts in elementary social studies textbooks grades 1-4. Theory and Research in Social Education 19(2), 211-220.

Hardwick, Susan W. (1995). Looking toward the future: A concepts, themes, and standards approach to preservice education. Journal of Geography 94(5), 513-518.

Harper, Robert A. (1992). At issue: What is geography's contribution to general education? Journal of Geography 91(3), 124-125.

Horton, Philip, B., McConney, Andrew A., Gallo, Michael, Woods, Amanda L., Senn, Gary J. & Hamelin, Denis (1993). An investigation of the effectiveness of concept mapping as an instructional tool. Science Education 77(1), 95-111.

Jones, Beau Fly and Idol, Lorna (Eds.) (1990). Dimensions of Thinking and Cognitive Instruction. Hillsdale, NJ: Lawrence Erlbaum Associates.

Keys, Carolyn W. (1995) Investigation of the relationship between scientific reasoning, contextualized knowledge, and concept acquisition in a naturalistic setting. Presentation at the annual meeting of the American Educational Research Association, San Francisco, CA.

King, Alison (1994). Guiding knowledge construction in the classroom: Effects of teaching children how to question and how to explain. American Educational Research Journal 31(2), 338-368.

Kuhn, Deanna, Garcia-Milla, Merce, Zohar, Anat, & Anderson, Christopher (1995). Strategies of Knowledge Acquisition. Monographs of the Society for Research in Child Development 60(4). Chicago, IL: Society for Research in Child Development.

Leinhardt, Gaea (1992). What research on learning tells us about teaching. Educational Leadership 49(7), 20-25.

Marker, Gerald & Mehlinger, Howard (1992). Social studies. In Philip W. Jackson (Ed.), Handbook of Research on Curriculum (pp. 830-851). New York: Macmillan Publishing Company.

Markham, Kimberly M., Mintzes, Joel J., & Jones, M. Gail (1994). The concept map as a research and evaluation tool: Further evidence of validity. Journal of Research in Science Teaching 31(1), 91-101.

Martorella, Peter H. (1991). Knowledge and concept development in social studies. In James P. Shaver (Ed.), Handbook of Research on Social Studies Teaching and Learning (pp. 370-384). New York: Macmillan Publishing Company.

McGilly, Kate (Ed.) (1994). Classroom Lessons: Integrating Cognitive Theory and Classroom Practice. Cambridge, MA: MIT Press.

Means, Mary L. & Voss, James F. (1996). Who reasons well? Two studies of informal reasoning among children of different grade, ability, and knowledge levels. Cognition and Instruction 14(2), 139-178.

Novak, Joseph D. (1990). Concept mapping: A useful tool for science education. Journal of Research in Science Teaching 27(10), 937-950.

Novak, Joseph & Musonda, Dismas (1991) A twelve-year longitudinal study of science concept learning. American Educational Research Journal 28(1), 117-153.

Osborne, Jonathan F. (1996). Beyond constructivism. Science Education 89(1), 53-82.

Patrick, John J. (1993). Achievement of goal three of the six national education goals. (ERIC Document Reproduction Service No. ED 360 221).

Persky, Hilary R., Reese, Clyde M., O'Sullivan, Christine Y., Laser, Stephen, Moore, Jerry, & Shakrani, Sharif (1986). NAEP 1994 Geography Report Card: Findings From the National Assessment of Educational Progress. Princeton, NJ: The National Assessment of Educational Progress.

Pressley, Michael & Afflerbach, Peter (1995). Verbal Protocols of Reading: The Nature of Constructively Responsive Reading. Hillsdale, NJ: Lawrence Erlbaum Associates

Reif, Frederick & Larkin, Jill H. (1991). Cognition in scientific and everyday domains: Comparison and learning implications. Journal of Research in Science Teaching 28(9), 733-760.

Resnick, L.B. & Collins, A. (1994). Cognition and learning. In Torsten Husen & T. Neville Postlethwaite (Eds.), International Encyclopedia of Education (2nd ed.) (pp. 835-838). Tarrytown, NY: Pergamon Press.

Resnick, Lauren B. & Klopfer, Leopold E. (Eds.) (1989). Toward the Thinking Curriculum: Current Cognitive Research. Alexandria, VA: Association for Supervision and Curriculum Development.

Reynolds, Ralph E., Sinatra, Gale M., & Jetton, Tamara L. (1996). Views of knowledge acquisition and representation: A continuum from experience centered to mind centered. Educational Psychologist 31(2), 93-104.

Roth, Kathleen J. (1990). Developing meaningful conceptual understanding in science. In Beau Fly Jones & Lorna Idol (Eds.), Dimensions of Thinking and Cognitive Instruction (pp. 139-176). Hillsdale, NJ: Lawrence Erlbaum Associates.

Roth, Wolff-Michael (1994). Student views of collaborative concept mapping: An emancipatory research project. Science Education 78(1), 1-34.

Shavelson, Richard J., Lang, Heather & Lewin, Bridget (1993). On concept maps as potential "authentic" assessments in science: Indirect approaches to knowledge representation of high school science. (ERIC Document Reproduction Service No. ED 367 691).

Spoehr, Kathryn T. (1994). Enhancing the acquisition of conceptual structures through hypermedia. In K. McGilly (Ed.), Classroom Lessons: Integrating Cognitive Theory and Classroom Practice (pp. 75-103). Cambridge, MA: MIT Press.

Stein, Mary Kay, Baxter, Juliet A., & Leinhardt, Gaea (1990). Subject-matter knowledge and elementary instruction: A case from functions and graphing. American Educational Research Journal 27(4), 639-663.

Stoltman, Joseph P. (1991). Research on geography teaching. In James P. Shaver (Ed.), Handbook of Research on Social Studies (pp. 437-447). NY: Macmillan Publishing Company.

Stoltman, Joseph P. (1995). The national geography content standards. (ERIC Document Reproduction Service No. ED 381 480).

Tamir, P. (1991). Concept mapping. In Arieh Levy (Ed.), International Encyclopedia of Curriculum (pp. 333-335). Tarrytown, NY: Pergamon Press.

Thornton, Stephen J. & Wenger, R. Neill (1990). Geography curriculum and instruction in three fourth-grade classrooms. Elementary School Journal 90(5), 515-531.

Torney-Purta, Judith (1991). Schema theory and cognitive psychology: Implications for social studies. Theory and Research in Social Education 19(2), 189-210.

Torney-Purta, Judith (1994). Dimensions of adolescents' reasoning about political and historical issues: Ontological switches, developmental processes, and situated learning. In Mario Carretero & James F. Voss (Eds.), Cognitive and Instructional Processes in History and the Social Sciences (pp. 103-122). Hillsdale, NJ: Lawrence Erlbaum Associates.

Trygestad, JoAnn (1997). Students' Conceptual Thinking in Geography. Unpublished dissertation. University of Minnesota.

Tytler, Russell & White, Richard (1996). Conceptual change in science: Towards a theory of content. Presentation at the annual meeting of the American Educational Research Association, New York.

van der Schee, Joop, van Dijk, Henk, & van Westrhenen, Hans (1992). Geographical procedural knowledge and map skills. In H. Schrettenbrunner & J. van Westrhenen (Eds.), Empirical Research and Geography Teaching Utrecht: Koninklijk Nederlands Aardrijkskundig

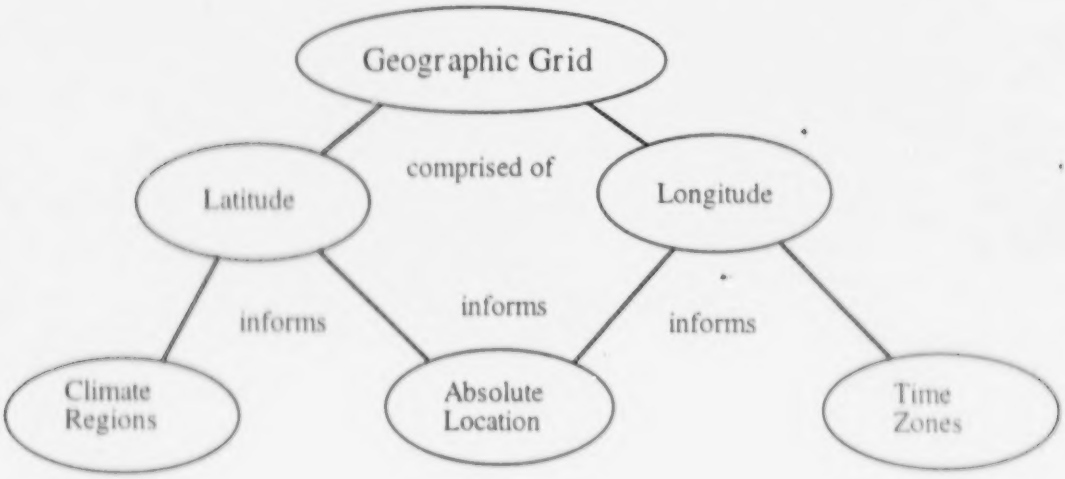
White, Richard & Gunstone, Richard (1992). Probing Understanding. New York: Falmer Press.

Wigfield, Allan, Eccles, Jacquelynne S., & Pintrich, Paul R. (1996). Development between the ages of 11 and 25. In David C. Berliner & Robert C. Calfee (Eds.), Handbook of Educational Psychology (pp. 148-185). New York: Macmillan Publishing Company.

Wilcox, Clyde & Williams, Leonard (1990). Taking stock of schema theory. Social Science Journal 27(4), 373-393.

Figure 1

Example of a Concept Map in Geography



Appendix 2

Experts' Identification of Salient Geographic Concepts

All Experts	7 of 8 Experts	6 of 8 Experts	5 of 8 Experts
Interaction	Culture	Ecosystem	Change
Space	Environment	Movement	Location
	Human Phenomena	Spatial Distribution	Maps
	Physical Phenomena		Population
	Place		Scale
	Region		Settlement
	Spatial Organization		Society

4 of 8 Experts	3 of 8 Experts	2 of 8 Experts	1 of 8 Experts
Latitude &	Adaptation	Hierarchy	*Bodies of Water
Longitude	Boundaries	*Human Modification	*Connect/Link
Models	Citizenship	*Mental Models	*Earth
Pattern	Climate	*Migration	*Economic Activities
System	Conflict	Nation-State	*Economic
Urbanization	Continent	*Perspective/Perception	Development
	*Cooperation	*Process	*Erosion
	Cultural Mosaic	*Resource	*Essential Elements
	Distribution	*Themes	*Landforms
	Diversity	*Skills	*Landscapes
	Interdependence	*Acquiring	*Organisms
	Site/Situation	*Organizing	*Political Geography
	*Spatial	*Analyzing	Route
	Symbol	*Asking	*Spatial Information
	Technology	*Answering	*Standards
		*Uses	

Note. Concepts added by geographic experts are starred.

Table 3

Geographic Concepts Identified as Salient by Fifty Percent of Geographic Experts

Change	Place
Culture	Population
Ecosystem	Region
Environment	Resource
Human Phenomena	Scale
Interaction	Settlement
Latitude & Longitude	Society
Location	Space
Map	Spatial Distribution
Movement	Spatial Organization
Pattern	System
Perspective	Urbanization
Physical Phenomena	

Appendix 4

Frequency and Percentage of Concepts Correctly Identified and Used by Students According to Achievement Levels (Low, Average, High) and Grade Levels (6, 9, 12)

Concepts	6th Grade[a]			9th Grade[b]			12th Grade[c]			Total[d]		
	Low	Avg	High	Low	Avg	High	Low	Avg	High	Low	Avg	High
	Freq	Freq	Freq	Freq	Freq	Freq	Freq	Freq	Freq	Freq	Freq	Freq
	%	%	%	%	%	%	%	%	%	%	%	%
Change	1	5	4	4	5	7	3	7	7	8	17	18
	14	63	50	57	71	88	43	100	100	38	77	78
Culture	5	7	5	7	7	8	6	7	7	18	20	20
	71	88	63	100	100	100	86	100	100	86	96	87
Ecosystem	1	1	3	4	4	6	5	5	7	10	10	16
	14	13	38	57	57	75	71	72	100	48	46	70
Environment	4	7	7	7	6	8	6	5	7	17	18	22
	57	88	88	100	86	100	86	71	100	81	82	96
Human	0	0	0	0	2	2	1	2	5	1	4	7
Phenomena	0	0	0	0	29	25	14	29	71	5	18	30
Interaction	0	0	1	3	5	5	3	6	6	6	11	12
	0	0	13	43	71	63	43	86	86	29	50	52
Latitude &	5	6	7	6	7	8	6	6	7	17	19	22
Longitude	71	75	88	86	100	100	86	86	100	81	86	96
Location	7	8	8	7	5	8	7	6	7	21	19	23
	100	100	100	100	71	100	100	86	100	100	86	100
Map	7	8	8	6	7	8	4	74	7	17	22	23
	100	100	100	86	100	100	57	100	100	81	100	100
Movement	2	2	1	3	5	3	3	6	7	8	13	11
	29	25	13	43	71	38	43	86	100	38	59	48
Pattern	1	1	1	2	3	4	4	3	6	7	7	11
	14	13	13	29	43	50	57	43	86	33	32	48
Perspective	1	0	1	2	4	3	3	1	7	6	5	11
	14	0	13	29	57	38	43	14	100	29	23	48
Physical	0	0	0	0	3	2	0	2	5	0	5	7
Phenomena	0	0	0	0	43	25	0	29	71	0	23	30

Frequency and Percentage of Concepts Correctly Identified and Used by Students According to Achievement Levels (Low, Average, High) and Grade Levels (6, 9, 12) (continued)

Concepts	6th Grade[a]			9th Grade[b]			12th Grade[c]			Total[d]		
	Low	Avg	High	Low	Avg	High	Low	Avg	High	Low	Avg	High
	Freq	Freq	Freq	Freq	Freq	Freq	Freq	Freq	Freq	Freq	Freq	Freq
	%	%	%	%	%	%	%	%	%	%	%	%
Place	4	6	7	6	7	6	5	5	7	15	18	20
	57	75	88	86	100	75	71	71	100	71	82	87
Population	5	7	7	6	6	8	6	7	7	17	20	22
	71	88	88	86	86	100	86	100	100	81	91	96
Region	3	3	8	7	6	7	7	6	7	17	15	22
	43	38	100	100	86	88	100	86	100	81	68	96
Resource	2	3	2	3	6	6	7	6	7	12	15	15
	29	38	25	43	86	75	100	86	100	57	68	65
Scale	3	2	5	4	4	8	3	5	4	10	11	17
	43	25	63	57	57	100	43	71	57	48	50	74
Settlement	2	5	6	4	4	6	5	6	7	11	15	19
	29	63	75	57	57	75	71	86	100	52	68	83
Society	1	2	2	6	7	8	5	7	7	12	16	17
	43	25	63	57	57	100	43	71	57	48	50	74
Space	2	3	5	3	4	6	3	3	7	8	10	18
	29	38	63	43	57	75	43	43	100	38	46	78
Spatial	0	0	1	0	1	5	4	3	7	4	4	13
Distribution	0	0	13	0	14	63	57	43	100	19	18	57
Spatial	0	0	2	0	1	3	2	2	7	2	3	12
Organization	0	0	25	0	14	38	29	29	100	10	14	52
System	1	3	2	1	1	4	1	4	6	3	8	12
	14	38	25	14	14	50	14	57	86	14	36	52
Urbanization	0	0	4	1	4	5	3	6	7	4	10	16
	0	0	50	14	57	63	43	86	100	19	46	70
Other	0	0	2	0	0	1	0	3	0	0	3	3
Concepts	0	0	25	0	0	13	0	43	0	0	14	13
Total %	34	40	50	53	65	73	58	72	94	47	57	71

Note. Other concepts were: Hemispheres, Degrees, People, Religion, Area, Idea, Stability. [a]n = 7 (Low), 8 (Average), 8 (High). [b]n = 7 (Low), 7 (Average), 8 (High). [c]n = 7 (Low), 7 (Average), 7 (High). [d]n = 21 (Low), 22 (Average), 23 (High).

Table 5

Correlations Among Knowledge Questions, Number of Concepts, Total Concept Map Scores, Familiarity with Concepts, and Familiarity with Concept Maps

Elements	Knowledge Questions	No. of Concepts	Concept Map Scores	Familiarity with Concepts	Familiarity with Concept Maps
Knowledge Questions	—	.61***	.52***	.41**	-.25
Number of Concepts		—	.80***	.70**	.60**
Concept Map Scores			—	.58**	.49**
Familiarity with Concepts				—	.80**
Familiarity with Concept Maps					—

** $p < .01$.

*** $p < .001$.

Table 6

Results of Fisher's Modified LSD as Follow-Up t-Test for Knowledge Questions, Number of Concepts, and Concept Map Scores by Means of Academic Achievement Levels (Low, Average, High) and Grade Levels (6, 9, 12)

	Achievement Levels	
Instruments	Low Compared to Average	Average Compared to High
Knowledge Questions	1.29	2.84*
Number of Concepts	2.35*	2.08*
Concept Map Scores	1.71	1.59
	Grade Levels	
Instruments	6th Compared to 9th Grade	9th Compared to 12th Grade
Knowledge Questions	2.51*	2.33*
Number of Concepts	4.08*	1.98
Concept Map Scores	2.48*	2.88*

Note. Critical Value (for all tests) at $t_{.975(57)}=2.009$.

*$p < .05$.